THE PERFECT STAGE OF THE COTTON ANTHRACNOSE

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(With Plate 8, Containing Five Figures)

Perithecia of the genus *Glomerella,* the perfect stage of certain species of *Gloeosporium* and *Colletotrichum,* have been developed in most cases under artificial conditions, either in pure culture on artificial media or on old dead pieces of the host plant that have been kept in a moist condition. In only a few cases has the ascigeral stage been found developing naturally. The form from apple has been reported as occurring naturally, but even here the best development has been observed on artificial media or on diseased apples kept in a moist chamber.

While making a study of the cotton anthracnose, *Colletotrichum Gossypii,* in Louisiana during 1908, search was made at various times to discover whether the perithecial stage of this developed naturally on the cotton plant. Shear and Wood* have reported finding the perithecia in pure cultures, but their presence on the living cotton plant, or even on old dead parts of the plant, has never been reported. The anthracnose appears on all parts of the plant, cotyledons, leaves, stems and bolls, and search was made on all of these for the perfect stage. The conidial stage was especially abundant, and it is doubtful whether there was a single cotton plant in this section of the cotton belt that was not more or less affected with this stage, and, during the early part of the season, this stage alone was found.

However, on August 1, after a period of very warm and very wet weather, a single boll, picked while passing through a field at Baton Rouge, was examined in the laboratory and found to be covered with the perfect stage of the *Colletotrichum.* The boll was living, only about one half of it being covered with the

* Shear, C. L., and Wood, Anna K. Ascogenous Forms of *Gloeosporium* and *Colletotrichum.* Botanical Gazette 43: 259–266. 1907.

anthracnose, while the other half was perfectly green and healthy. Two days later, six bolls picked at random in different parts of the same field were examined, and three of them were found to contain perithecia. In only one case did the anthracnose cover the whole boll. On August 8, after a few days of comparatively dry weather, over a hundred bolls were brought in from the same field, but only two of these contained perithecia and they were small withered bolls. Again, on August 25, after another wet spell, fifty bolls were brought in from the same field and the perfect stage was found on four of these. In another field about a mile distant from the first one, bolls were also examined but with less success. Forty bolls picked August 4 showed no perithecia. However, toward the latter part of August, several bolls out of a considerable number were found to contain the perfect stage. From the conditions of temperature and humidity at the time, it seems possible that moisture and heat may be important factors in perithecial development in this species.

The study of the perithecia showed several interesting things. The perithecia were, as a rule, entirely embedded in the host tissue and only the more or less well-developed beaks extended through the epidermis of the boll. In only one instance (*pl. 8, f. 2*) were the perithecia observed on the surface of the boll. They were not collected together surrounding a nodule of fungus tissue as is commonly the case in this genus, but were more or less distinct and separate. Often they were so numerous that they crowded one another, but only rarely did they seem to have any connection with a common fungus stroma; often, also, the perithecia were entirely separate, each one being entirely surrounded by host tissue (*pl. 8, f. 3*).

A second interesting feature was the shape of the ascospores. *Glomerella* spores are generally more or less curved and elongate, while these were rarely curved and more elliptical (fig. 1, *a, b*). I have had the opportunity of studying spores from a number of different host plants, but I have seen in no other form, the short, thick, elliptical spores like those which occurred on the cotton. I have shown as a comparison, in fig. 1, *c*, ascospores that developed on the fig, *Ficus carica*. The perfect stage of this form has not hitherto been reported, but it does

not seem in any way distinct from the one on apple, *Glomerella fructigena* (Clinton) Sacc. Whether the shape of the ascospores of the cotton anthracnose was due to environment is a question. There is often considerable variation in the size of the ascospores from the same host as developed on different substrata, the spores developing on the host plant being as a rule smaller than those developing on nutrient media, but I have not noticed a varia-

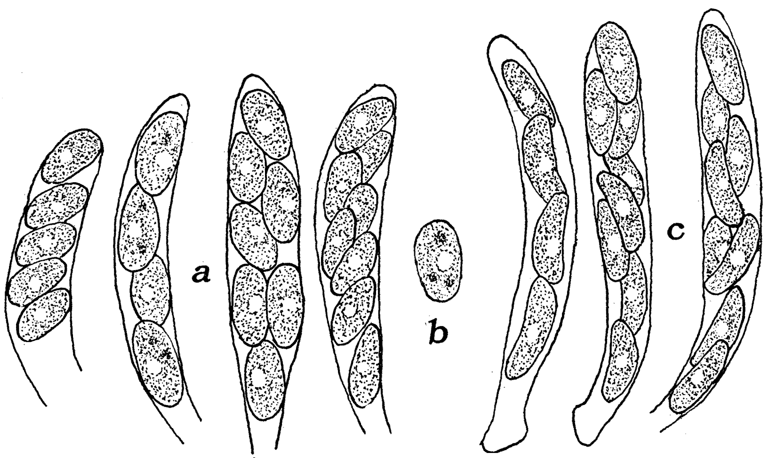

FIG. 1. Asci and ascospores of *Glomerella*. *a, Glomerella Gossypii,* asci and *ascospores; b,* same, typical ascospore; *c, Glomerella* from fruit of *Ficus carica,* showing asci and ascospores. All magnified 750 diameters.

tion in shape. As I have never seen ascospores of the cotton anthracnose that have developed on artificial media, I cannot compare them with those that developed naturally. But this difference in shape seems noteworthy and may represent a specific character.

A third feature, and the most interesting, developed from a study of the sterile threads which are now generally conceded to be present in all perithecia in this genus. The genus has been described at various times as (*a*) without paraphyses, (*b*) with paraphyses, and (*c*) with periphyses. These threads were so especially abundant in the perithecia from the cotton boll, that a good opportunity was offered for settling the point beyond a question. A large number of sections from 2 to 8 μ in thickness were made and studied. In many of the sections the sterile

threads were clearly seen, and their exact position in regard to the asci was shown. The presence of the threads between the asci was demonstrated with a certainty and can be clearly seen in the accompanying photomicrographs. While I have made scores of slides from other host plants, I was never before able to demonstrate their presence between the asci, and in a previous paper I expressed a doubt as to their occurrence in that position. The reason evidently lay in the better development of the threads in the perithecia from the cotton. These threads are much longer than the asci, extending to the ostiole of the perithecium, and entirely filling the cavity above the asci. If these sterile threads are to be called paraphyses, and there is little reason why they should not be called so, notwithstanding their length and irregularity, then the genus *Glomerella* must in the future be considered as paraphysate.

What effect this may have on retaining or discarding the generic name, *Glomerella,* cannot be told until some one has made a careful study of the various species of the genus *Physalospora.* Some of the perithecia of the cotton anthracnose fit perfectly the characters of the genus *Physalospora,* as shown in fig. 3, of the accompanying plate; however, others, as in fig. 2, do not. *Glomerella* perithecia, on artificial media or in a moist chamber, generally develop on the surface of the substratum and are not embedded in it, while *Physalospora* perithecia are not supposed to develop in this manner. But if it is found that members of this latter genus will develop on the surface of the substratum if the moisture conditions are suitable, then there are no generic characters separating the forms now resting in *Glomerella* and *Physalospora.* Several mycologists, such as Maublanc and Lasnier in France, and Sheldon in this country, are now calling the anthracnose forms *Physalospora;* but, until we know more of the development of these different forms, it seems best to keep them separate.

Although many of the anthracnoses found on different hosts are members of a single species, as has been shown by various investigators in the last few years, the evidence seems to show that some forms are distinct enough to represent different species. While morphologically the different forms are in many ways

similar, yet in some details there is considerable divergence in some of them. The form from cotton represents, perhaps, one of the most divergent types. I have studied this for some time and find no evidence for placing it in the same species with the organism causing the rot of various fruits. I have made many cultures at different times and from different places and find little variation in them. The characters which distinguish this from other forms may be briefly stated as follows: (1) A difference in color of the masses of spores, the cotton anthracnose spore-masses being more salmon than pink in color; (2) the abundance of setae; (3) the production of spores on the points of the setae; (4) the entirely distinct cultural characters; (5) the inability to inoculate satisfactorily other forms on cotton, or the cotton form on fruits, etc.; (6) the slight difference in the shape of the ascospores.

Consequently, believing that the evidence is sufficient to keep this form separate, I propose for it the following name and diagnosis:

Glomerella Gossypii sp. nov.

Perithecia distinct or crowded, very abundant, buried in the tissue of the host with only the beaks protruding, or rarely on the surface, dark brown to black, subglobose to pyriform, 80–120 × 100–160 μ, mostly about 115 × 140 μ. Beak of the perithecium sometimes 60 μ or more in length. Asci numerous, clavate, 55–70 × 10–14 μ, mostly 10–11 μ in thickness. Spores uniseriate or irregularly biseriate, nearly elliptical, or rarely slightly curved, granular, hyaline, showing a clear nucleus near the center, 12–20 × 5–8 μ, averaging 13–14 × 7 μ. Paraphyses long, slender, very abundant, filling the entire cavity of the perithecium above the asci.

Perfect stage of *Colletotrichum Gossypii* Southworth, which preceded and accompanied it. Bolls of *Gossypium herbaceum,* August, 1908, Baton Rouge, La. Type material, with prepared sections, deposited in the United States National Herbarium, Washington, D. C.

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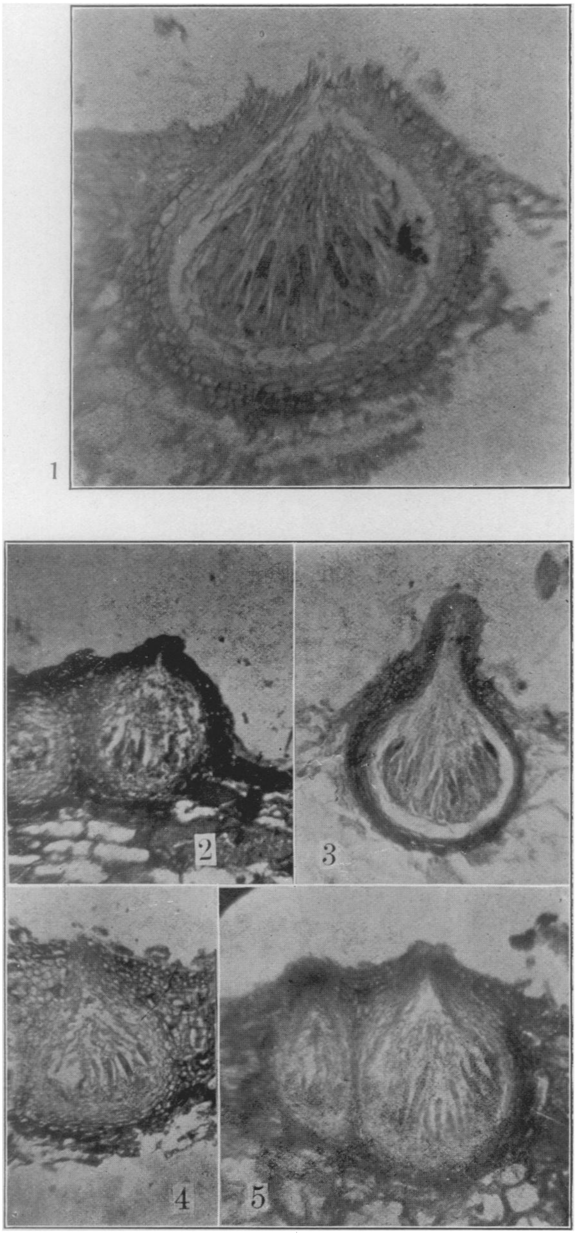
EXPLANATION OF PLATE VIII

FIGS. 1–5. *Glomerella Gossypii* sp. nov.

1. Perithecium showing the paraphyses, × 320.
2. Perithecium on surface of cotton boll, × 200.
3. Perithecium showing the beak that is commonly present, × 200.
4. An entirely imbedded perithecium, section 2 μ thick, showing three asci and the paraphyses between them, × 200.
5. Perithecium showing asci, paraphyses, and short beak, × 200.



GLOMERELLA GOSSYPII EDGERTON